# ELECTROCARDIOGRAPHIC EVIDENCE OF ABNORMAL VENTRICULAR PREPONDERANCE AND OF AURICULAR HYPERTROPHY.[1]

By Paul D. White, M.D.,

and

Arlie V. Bock, M.D.,

boston, massachusetts.

(From the Massachusetts General Hospital, Boston.)

The present communication summarizes a clinical investigation undertaken to define the electrocardiographic limits beyond which one may conclude the presence of abnormal ventricular preponderance and of auricular hypertrophy.

It has first been necessary to establish an index for the calculations. The following satisfactory formula was finally employed: the measurements are of the amplitudes of the string excursions expressed in tenths of a millivolt (millimeters on the photographic records):

$$(U_1 + D_3) - (D_1 + U_3) = I,^2$$

where $I$ signifies *index*, $U_1$ signifies the amplitude of the chief upward excursion of the QRS group in Lead $I_3$, and $D_3$ signifies the amplitude of the chief downward excursion of the QRS group in Lead III; $D_1$ and $U_3$ are interpreted correspondingly.[3] For example, if $U_1$ measures 16 millimeters, $D_1$ 3 mm., $U_3$ 5 mm., and $D_3$ 22 mm., the index $= (16 + 22) - (3 + 5) = +30$; if $U_1$ equals 4 mm., $D_1$ 18 mm., $U_3$ 19 mm., and $D_3$ 0 mm., the index equals $(4 + 0) - (18 + 19) = -33$.

An increase of the index in the positive direction indicates a swing of the electrical axis to the left either from actual change in cardiac position or from increase of left muscle mass in the heart itself; a change toward the negative values indicates a swing of the electrical axis to the right.

For controls we have examined 100 normal people: 60 young male adults, 20 young female adults, 20 children under nine years of age and 20 old people over sixty-five years of age. Dr. E. B. Krumbhaar has kindly sent us his table of measurements[4] of 41 children and we have also used the figures of Lewis and Gilder[5] in

[1] Read in part before the American Society for Clinical Investigation, Atlantic City, N. J., May 1, 1917. The call to active service abroad delays the publication of a detailed report of this investigation with complete tables.

[2] A similar formula was mentioned by Lewis, Heart, 1914, v, 398.

[3] The average of several successive beats should be taken to avoid respiratory variations in amplitude.

[4] This table has since been published in Heart, 1917, vi, 189.

[5] Philosophical Transactions of Royal Society, 1912, ccii, B. 351.

their study of 52 normal young male adults. Our high positive and negative indices have been found among 1100 cases electrocardiographed at the Massachusetts General Hospital.

It was of considerable interest to note in the case of the electrocardiogram of old age that not infrequently the index was nearer the average normal value than that of a number of the healthy children with relatively high positive values. When a decidedly high positive value was found in an old person, marked arteriosclerosis, hypertension or aortic regurgitation was also found. It would seem then that old age *per se* does not give a characteristic electrocardiogram.

The individual electrocardiogram is remarkably constant, as a rule, in the value of the index. In 12 cases the maximum individual variation over periods of three months to two years was found to be +4. In a few cases, more particularly those with aberrant ventricular complexes, as in bundle branch block with progressive heart disease, there may be considerable variation: 3 of our cases —all with aberrant ventricular complexes—showed variations of −25, −17 and −34 in the index over periods of five months to two years. Electrocardiograms of cases such as these cannot be used in the estimation of ventricular preponderance.

In the course of this investigation it was found by comparison of electrocardiograms with fluoroscopic tracings that cardiac position has an important bearing on the index, and a respiratory test has been used. The position of the heart as determined by the type of the individual being studied, for example, squat or lanky, very likely affords the explanation for the occasional discrepancies between ventricular weights and electrocardiograms. Incidentally it may be noted here that the position of the diaphragm has much more influence on the inclination of the actual cardiac axis, and therefore on the electrocardiographic index than have pneumothorax or pleural effusions. These, if large, generally push the heart *in toto* to one side or the other with little or no change in the inclination of the axis; if there is a change in the axis it may actually be due to a greater displacement of the base than of the apex.

By the use of the preponderance index described above in the electrocardiographic study of 1200 individuals, values of +20 and −15 have been found to be close to the border-line of normality (Tables I and II). Indices of +20 to +30 and of −15 to −18 have usually indicated left and right ventricular preponderance respectively and those beyond +30 and −18 have always indicated ventricular preponderance in our series. The highest values in normal people indicate, as a rule, unusual cardiac position; for instance, a fairly high positive value in a short, fat person really indicating a horizontal position rather than left preponderance and a fairly high negative value in a tall, long-chested individual indicating a

"vertical heart." The respiratory test which by inspiration lowers the diaphragm and straightens the heart and by expiration acts in the opposite way is useful in the analysis of doubtful cases. Left ventricular preponderance in a short-chested person would give rise to an electrocardiogram of exaggerated left ventricular preponderance.

*P* deflections over $3 \times 10^{-4}$ millivolts in amplitude or over 0.1 second in duration almost always indicate the presence of auricular hypertrophy (Table III).

TABLE I.—TABLE OF LEFT VENTRICULAR PREPONDERANCE.

| Index of preponderance. | Total number of cases. | Aortic regurgitation. | Blood-pressure of 180 mm. or more without aortic regurgitation. | Aorta dilated or roughened without aortic regurgitation or hypertension. | Miscellaneous. |
|---|---|---|---|---|---|
| Above +30 . | 21 | 9 | 12 | 0 | |
| +20 to +30 inclusive | 61 | 22 | 18 | 11 | 10 (8 normal) |
| Total . . . | 82 | 31 | 30 | 11 | 10 |

Respiratory test on 10 of first three groups; index of 8 stayed high. Index of 5 of last group became normal with respiratory test.

TABLE II.—TABLE OF RIGHT VENTRICULAR PREPONDERANCE.

| Index of preponderance. | Total number of cases. | Mitral etenosis. | Rheumatic mitral disease without stenosis. | Pulmonary stenosis (congenital heart) | Chronic emphysema. | Normal. |
|---|---|---|---|---|---|---|
| Beyond −18 . | 15 | 9 | 2 | 3 | 1 | 0 |
| −15 to −18 inclusive | 7 | 4 | 0 | 0 | 0 | 3 |
| Total . . . | 22 | 13 | 2 | 3 | 1 | 3 |

TABLE III.—ENLARGED P DEFLECTION.

Over $3 \times 10^{-4}$ volts in amplitude, or over 0.1 sec. wide, or both.

| Total number of cases. | Mitral stenosis. | Rheumatic mitral disease without stenosis. | Hyperthyroidism. | Miscellaneous. | Right ventricular preponderance index of −15 or beyond. | Preponderance index minus. |
|---|---|---|---|---|---|---|
| 20 | 21 | 5 | 1 | 1 with paroxysmal tachycardia.<br>1 with paroxysmal auricular fibrillation.<br>1 with syphilis. | 11 | 19 |

One case with +17 had aortic stenosis as well as mitral stenosis.